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ABSTRACT

Designed for the student who has competence in general mathematical skills and who has interest in solving practical problems, this guidebook on minimum course content seeks further development of computational and problem solving skills through the applications of trigonometry and base ten logarithms. Overall course goals are specified, a course outline and suggested teaching strategies are provided, performance objectives are listed and text references and a sample posttest are included. (JP)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

DADE COUNTY PUBLIC SCHOOLS

PRACTICAL TRIGONOMETRY

5219.05

MATHEMATICS

DIVISION OF INSTRUCTION • 1971

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QUINMESTER MATHEMATICS

COURSE OF STUDY

FOR

PRACTICAL TRIGONOMETRY

5219.05

(EXPERIMENTAL)

Written by
Carolyn B. Worthington

for the

DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida 33132
1971 - 72

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PREFACE

The following course of study has been designed to set a minimum standard for student performance after exposure to the material described and to specify sources which can be the basis for the planning of daily activities by the teacher. There has been no attempt to prescribe teaching strategies; those strategies listed are merely suggestions which have proved successful at some time for some class.

The course sequence is suggested as a guide; an individual teacher should feel free to rearrange the sequence whenever other alternatives seem more desirable. Since the course content represents a minimum, a teacher should feel free to add to the content specified.

Any comments and/or suggestions which will help to improve the existing curriculum will be appreciated. Please direct your remarks to the Consultant for Mathematics.

All courses of study have been edited by a subcommittee of the Mathematics Advisory Committee.

CATALOGUE DESCRIPTION

A course in applications of trigonometry. Emphasis is on computation; certain techniques of elementary algebra will be developed to be used in problem solving; computation with base ten logarithms will be introduced.

Designed for the student who has competence in general mathematics skills and who has interest in solving practical problems.

TABLE OF CONTENTS

Goals 3
Performance Objectives, Course Outline, Strategies, and References
I 4
II 6
III 9
IV 11
V 12
VI 14
VII 15
VIII 16
Evaluative Devices 17
Bibliography 32

GOALS

The goals of this quin will include:

1. The understanding of simple equations necessary for studying elementary trigonometry.

2 A review of the properties of similiar triangles.

3. The improving of manipulative skills when working with scientific notation.

4. The understanding of the properties of logarithms as well as computation with common logarithms.

5. The solving of practical problems by applying the definitions of the trigonometric functions as applied to right triangles.

6. The introduction to trigonometric functions of any angle.

7. The promoting of an appreciation of the need for the study of trigonometry in trades, industry, astronomy, and navigation.

PERFORMANCE OBJECTIVES

The student will:

I. 1. Solve simple equations by applying the properties of equality.

2. Solve proportions of the form $\frac{a}{b} = \frac{k_1}{k_2}$

COURSE OUTLINE

I. Solving Simple Equations

A. Use of the addition and subtraction properties of equality.

B. Use of the division and multiplication properties of equality.

C. Proportions of the form $\frac{a}{b} = \frac{k_1}{k_2}$

STRATEGIES AND REFERENCES

I. 1. A straight forward approach to simple equations stressing by illustration, the use of equations in various trades would show that from the beginning this is a PRACTICAL course. Basic properties to be introduced: Given a, b, c, are rational numbers

if $a = b$ then $a + c = b + c$

if $a = b$ then $a - c = b - c$

if $a = b$ and $c \neq 0$ then $\frac{a}{c} = \frac{b}{c}$

if $a = b$ then $a \cdot c = b \cdot c$

STRATEGIES AND REFERENCES

I. 1. Basic Mathematics Simplified, p. 260, 266

Algebra Two (Payne, et al), p. 28, 21

Machine Shop Mathematics, p. 95, p. 99, p. 91, p. 93

2. Electrical Trades, p. 47

Automotive Trades, p. 81

Machine Shop Mathematics, p. 122

Basic Mathematics Simplified, p. 279, 291

Carpentry Trades, p. 72

Geometry (Moise, Downs), p. 324

It is suggested that teachers of this quin have the following books for minimum reference work:

Bibliography items 1 and 9-13

Bibliography items 2 or 7

Biliography item 4 for practical problems.

PERFORMANCE OBJECTIVES

The student will:

II. 1. find the square root of a positive rational number by using the approximation method and by using tables.

2. solve for a, b, or c given the Pythagorean Theorem.

3. distinguish between triangles that are similar and those which are not similar.

4. find the length of a side of a triangle given one of the sides and the dimensions of a similar triangle.

5. distinguish between an acute triangle and an obtuse triangle.

6. define the units in the sexagesimal or degree system.

COURSE OUTLINE

II. Triangles

A. Right Triangles and the Pythagorean Theorem.

1. Square Roots

2. Pythagorean Theorem

B. Similar Triangles

C. Acute and Oblique Triangles

STRATEGIES AND REFERENCES

II. 1. For the approximation or 'long division' method and exercises see:

Basic Mathematics Simplified, p. 306

Math for Electrical Trades, p. 43

Math for Sheet Metal Fabrication, p. 215

Math for Plumbers and Pipefitters, p. 11

For using tables see:

Basic Mathematics Simplified, p. 315

STRATEGIES AND REFERENCES

II. 2. Problems and ideas are available in many Algebra I books.

Also see:

Exploring Modern Mathematics (Keedy), p. 232

Mathematics for Electrical Trades, p. 70

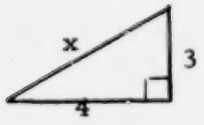
Mathematics for Sheet Metal Fabrication, p. 216

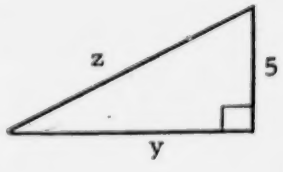
Mathematics for Plumbers and Pipefitters, p. 10

3. "Ratios of the lengths of corresponding sides of right triangles having congruent acute angles are equivalent" or other 'casually' worded statements may be illustrated by example, prepared acetates, or pictures.

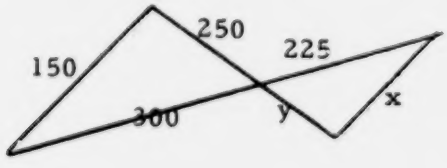
See Geometry (Moise-Downs), p. 321

4. For example: Find x, y, and z given: the similar triangles





or, Find x and y given:



See Geometry (Moise, Downs), p. 326

and Algebra I (Dolciani, 1962), p. 498

STRATEGIES AND REFERENCES

II. 5. See Basic Mathematics Simplified, p. 348
and Algebra I (Dolciani, 1962), p. 498

6. "Sexagesimal" is derived from the Latin word sexagesimus meaning "sixtieth". Main idea is for students to know that $\frac{1}{360}$ of a circle is one degree and that one degree is equal to 60 minutes which is equal to 3600 seconds.
See Algebra I (Dolciani, 1962), p. 481
and Basic Mathematics Simplified, p. 107.

PERFORMANCE OBJECTIVES

The student will:

III. 1. define the trigonometric functions of the right triangle.

2. calculate the values of the functions of angles of right triangles having sides 3, 4, and 5, and 5, 12, 13.

3. calculate the values of the functions of angles having 30, 45, and 60 degrees.

4. determine the numerical value of a trigonometric function of a given angle using a table and interpolation.

5. determine the angle from a table given the value of a trigonometric function.

COURSE OUTLINE

III. Trigonometric functions of the right triangle.

A. Definitions.

B. Application to 3, 4, 5 and 5, 12, 13 right triangles.

C. Functions of 30, 45, and 60 degree right triangles.

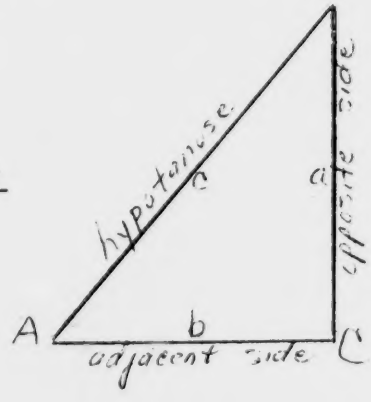
D. Tables of values of trigonometric functions.

1. Use of Tables.

2. Interpolation.

STRATEGIES AND REFERENCES

III. 1. $\text{Tan } A = \frac{a}{b} = \frac{\text{opposite side}}{\text{adjacent side}}$



See: Basic Mathematics Simplified, p. 380

Algebra 2 (Payne, et al), p. 482

Geometry (Moise, Downs), p. 353

STRATEGIES AND REFERENCES

III. 2. For example $\cos A \quad \frac{a}{c} = \frac{5}{12} = .385$;

decimal value to nearest thousandth optional.

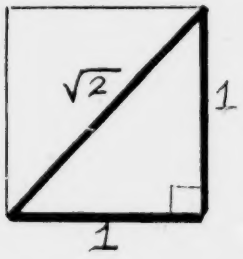
See:

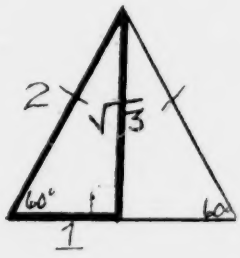
Basic Mathematics Simplified, p. 386

Algebra 2, (Payne, et al), p. 486

Geometry, (Moise, Downs), p. 353

3. Using a geometric approach such as





the students might prepare their own table of values of the functions of angles having 30°, 45°, and 60°.

Note:

Algebra 2 (Dolciani), p. 497

Geometry (Moise, Downs), p. 357

4. See:

Geometry (Moise, Downs), p. 357

Basic Math. Simplified, p. 84

Algebra 2 (Dolciani) p. 499

5. See '4' above.

PERFORMANCE OBJECTIVES

The student will:

IV. 1. distinguish between exact and approximate numbers,

2. determine if digits are significant or not significant.

3. distinguish between precision and accuracy of a measurement.

4. apply rules for operations with rounded and approximate numbers.

COURSE OUTLINE

IV. Calculation Aids

A. Exact Numbers.

B. Approximate Numbers.

1. Significant digits.

2. Precision and accuracy.

3. Rules for operations.

STRATEGIES AND REFERENCES

IV. Modern trigonometry (Welchons, et al), p. 236 is a good reference; however, it is no longer a state adopted textbook, but is available in most Dade County High Schools. Also see Algebra 2, (Dolciani) p. 411 and p. 419.

All future calculations should be expressed with answers in accordance with the use of significant digits.

PERFORMANCE OBJECTIVES

The student will:

V. 1. express any given rational number in scientific notation.

2. express as a rational number a number given in scientific notation.

3. estimate products or quotients, first using scientific notation, to a specified number of significant digits.

4. state the laws of exponents and identify the correct law to perform operations proficiently.

5. recognize that the laws of exponents are the basis for the properties of logarithms since logarithms are exponents.

6. interpolate when using tables of common logarithms.

7. apply the properties of logarithms when solving numerical and practical problems using common logarithms.

COURSE OUTLINE

V. Exponents and Common Logarithms

A. Scientific Notation.

B. Laws of Exponents and Properties of Logarithms.

C. Use of Tables of Common Logarithms.

D. Solution of Numerical and Practical Problems.

STRATEGIES AND REFERENCES

V. 1. See Algebra 2 (Dolciani), p. 413 and Modern trigonometry (Welchons), p. 241.

2. See '1' above.

3. See 1 and 2 above. If a calculator is available it would be a good opportunity for the students to use it to check on their estimates for problems such as:

Give a one significant digit estimate of $\frac{(20.47)\,(0.09)\,(0.791)}{42}$

4. See:

Algebra 2 (Dolciani), p. 420, p. 424.

Modern trigonometry (Welchons), p. 258.

Algebra 2 (Payne), p. 394.

5. Page 258, Modern trigonometry (Welchons) is a good reference to use with numerical illustrations such as

$\log_{10} 100 = 2$

$100 = 10^2$

then $10^2 \cdot 10^3 = 10^{2+3}$

$\log_{10}(10^2 \cdot 10^3) = 2 + 3$

$\log_{10}(10^2 \cdot 10^3) = \log_{10}(100 \cdot 1000)$

$\log_{10}(10^5) = 5$

6. Note Algebra 2 (Dolciani), p. 426.

Algebra 2 (Payne), p. 405.

7. See: Algebra 2 (Payne), p. 395, p. 401.

Algebra 2 (Dolciani) p. 423, p. 426.

Modern trigonometry (Welchons) p. 260.

PERFORMANCE OBJECTIVES

The student will:

VI. 1. do right triangle calculations given (1) two legs, (2) one leg and the hypotenuse, (3) one angle and the opposite leg, (4) one angle and the adjacent leg, and (5) one angle and the hypotenuse.

2. solve problems about right triangles using logarithms.

COURSE OUTLINE

VI. Right Triangle Calculations

A. Five Step Approach to Right Triangle Calculations.

B. Right Triangle Calculations Using Logarithms.

STRATEGIES AND REFERENCES

VI. 1. A ditto of a sketch of a right triangle and a problem illustrating each of the five types of right triangle calculations used in conjunction with illustrations placed on the chalkboard in class would systematically introduce basic right triangle calculations.

Problems may be found in the following:

Algebra 2 (Payne), p. 495.

Algebra 1 (Dolciani), p. 503, 506, 508.

Algebra 2 (Dolciani), p. 518, 521.

Machine Shop Mathematics, p. 167.

Modern Trigonometry (Welchons) p. 151.

VI. 2. Algebra 2 (Payne), p. 497, 491, 494.

Algebra 2 (Dolciani) p. 521 - 523.

Modern Trigonometry, (Welchons), p. 153.

PERFORMANCE OBJECTIVES

The student will:

VII. 1. solve verbal problems related to sheet metal work, carpentry, machine shop, automotive trades, electricity, and navigation.

2. apply the solution of right triangles in projects ie., measure the height of a flag pole, or a water tower, or a TV transmitting tower, or the width of a canal or street where an overhead crosswalk is available.

COURSE OUTLINE

VII. Practical Applications of Trigonometry.

STRATEGIES AND REFERENCES

VII. 1. Machine Shop Mathematics, p. 168 and Mathematics for Sheet Metal Fabrication, p. 229. Also refer to references in VI. 2. for many other word problems that may be solved using logarithms. Modern Trigonometry (Welchons) p. 289. By far the best source for problems is Trigonometry for Secondary Schools (Butler-Wren) p. 84 - 102 which contains at least 50 good word problems.

2. Obtain ideas from references listed above.

PERFORMANCE OBJECTIVES

The student will:

VIII. 1. Demonstrate knowledge of the fact that the trigonometric functions apply to any angle.

COURSE OUTLINE

VIII. Trigonometric Functions of Any Angle

STRATEGIES AND REFERENCE

VIII. Since this quin deals exclusively with solution of right triangles, the student should be made aware of the fact that trig functions do apply to any angle. See Algebra 2 (Payne), p. 499.

PRETEST

(Note: this test is designed to determine the readiness of the student about to take this quin.)

1. Reduce to lowest terms:

   A) $\frac{14}{42}$ B) $\frac{13}{65}$ C) $\frac{1.08}{.72}$

2. Perform the indicated operations:

   A) $\begin{array}{r} 1.706 \\ .23 \\ +12.051 \\ \hline \end{array}$ B) $\begin{array}{r} 6.2401 \\ -\ .9827 \\ \hline \end{array}$ C) $\begin{array}{r} 82.7 \\ \times\ 1.03 \\ \hline \end{array}$ D) $1.06\overline{)70.63}$

3. How do you write the ratio 7 to 8 as a fraction? as a decimal?

4. Define:

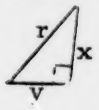
   A) acute angle

   B) right angle

   C) obtuse angle

   D) right triangle

5. State the Pythagorean theorem in terms of x, y and r, then find r if x is 5 and y is 12.



6. Solve:

   A) $2x - 3 = 15$

   B) $x + 7 = 13$

   C) $\frac{x}{5} = 3$

   D) $7x = 3$

7. Draw two triangles which are similar to each other.

8. In a right triangle one acute angle has a measure of 57°. Find the measure of the other acute angle.

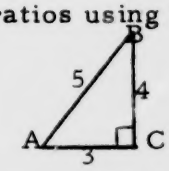
9. If a circle contains 360°, $\frac{1}{360}$ of a circle is __?__ degree(s).

PRETEST

10. Express the following ratios as decimals to three decimal places:

A) $\frac{5}{13}$, B) $\frac{12}{13}$, C) $\frac{5}{12}$, D) $\frac{4}{5}$, E) $\frac{3}{5}$

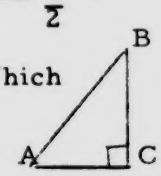
11. Given the triangle ABC, write the following ratios using the numbers given:



a) $\frac{BC}{AB}$; b) $\frac{AC}{AB}$; c) $\frac{BC}{AC}$; d) $\frac{AB}{AC}$

12. What is the least common denominator of the fractions $\frac{3}{8}, \frac{1}{6}$, and $\frac{1}{2}$?

13. Given the right triangle ABC, which side is the hypotenuse? Which side is adjacent to angle A? Which side is opposite angle B?

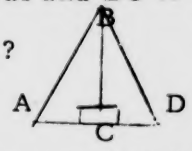


14. Evaluate: a) $2^3 \cdot 2^2$; b) $10^2 \cdot 10^4$; c) $3^2 \cdot 3^3$

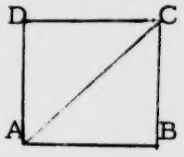
15. Write the following in scientific notation.

a) 623 ; b) 1,023 ; c) 1.23 ; d) 1.124

16. Given $\triangle$ ABC is equilateral and BC is the altitude to base AD. If AB is 4 in., how long is AC?



17. Given the square ABCD, AC is called the _____. How many degrees are there in angle CAB?



18. Find x if

a) $\frac{6}{8} = \frac{x}{4}$

b) $\frac{x}{2} = \frac{5}{12}$

c) $\frac{x}{7} = \frac{16}{28}$

19. Find the square roots of: a) 16, b) 121, c) 244.

20. Round the following to the nearest tenth:

a) 12.07 ; b) 165.84 ; c) 231.

PRETEST ANSWERS

1. A) $\frac{1}{3}$

   B) $\frac{1}{5}$

   C) $\frac{3}{2}$

2. A) 13.987

   B) 5.2574

   C) 85.181

   D) 66.63

3. $\frac{7}{8}$

   .875

4. A) an angle of measure Θ where $0 \leq \Theta < 90°$

   B) an angle of measure Θ where $\Theta = 90°$

   C) an angle of measure Θ where $90° < \Theta \leq 180°$

   D) a triangle having one right angle.

5. A) $x^2 + y^2 = r^2$

   B) $25 + 144 = r^2$

   $169 = r^2$

   $r = 13$

6. A) $2x - 3 = 15$

   $2x = 18$

   $x = 9$

   B) $x + 7 = 13$

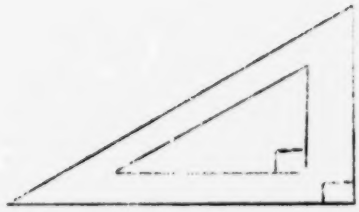
   $x = 6$

PRETEST ANSWERS

C) $\frac{x}{5} = 3$ $\quad x = 15$

D) $7x = 3$

$x = \frac{3}{7}$

7. 

8. 33°

9. 1°

10. A) .385

B) .923

C) .417

D) .800

E) .600

11. a) $\frac{4}{5}$

b) $\frac{3}{5}$

c) $\frac{4}{5}$

d) $\frac{5}{3}$

12. 24

13. a) AB b) AC c) AC

PRETEST ANSWERS

14. a) 32

    b) 1,000,000

    c) 243

15. a) 6.23×10^2

    b) 1.023×10^3

    c) 1.23×10^0

    d) 1.124×10^0

16. 2 in.

17. diagonal $\angle CAB = 45°$

18. A) $x = 3$

    B) $x = \frac{5}{6}$

    C) $x = 4$

19. a) 4

    b) 11

    c) 15.62

20. a) 12.1

    b) 165.8

    c) 231.0

POST TEST

(Note: These are simple test items. In some cases only one or two of each type here would need be on a test.)

I. 1. Solve: a) $3x - 4 = 26$

b) $5x + 2 = 27$

c) $\frac{34}{5} = 6$

d) $22x = \frac{2}{3}$

2. What is the ratio of the R. P. M. of two motors if the first motor turns 2100 R. P. M. and the second motor turns 3900 R. P. M.?

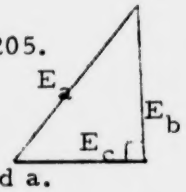
A pulley has a diameter of 27 inches. A second pulley has a diameter of 15 inches. What is the ratio of the diameter of the first pulley to that of the second?

If x varies as y and x is 12 when y is 7, find y when x is 18.

II. 1. Evaluate $\frac{\sqrt{420}}{100}$.

Find $\sqrt{10.71}$ correct to hundredths and check the accuracy of the answer by referring to a table of square roots.

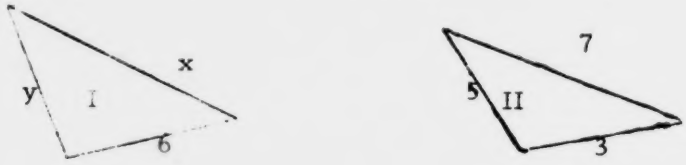
2. Find E_a, the voltage, given E_c is 220 volts and E_b is 205.



Given $C^2 = a^2 + b^2$; $b = 25$, $c = 200$; Find a.

3. If the lengths of the corresponding sides of two triangles are proportional the triangles are said to be ___?___.

4. Given triangles I and II are similar, find x and y.



5. Does a right triangle ever contain an obtuse angle? Give the reason for your answer.

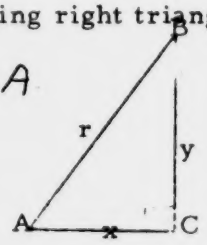
   Any triangle will have at most_____obtuse angles.

6. One degree _____ seconds.

   One second _____ minutes.

   If an angle has 57° 37' and it is bisected (the measure is divided by 2) the resulting measure will be _____.

III. 1. Given the following right triangle, define the six trigonometric functions for $\angle A$



2. If, in the right triangle in (1.) above, r = 5, x = 3, and y = 4; find the values of the six trigonometric functions to 4 places.

3. Calculate without using tables the values of the following:

   a) sin 30° b) cos 60° c) tan 45° d) cot 30° e) sec 60°

   f) csc 45°

POST TEST

III. 4. Find the numerical value of the following:

sin 20° 17' cot 37° 18'

cos 67° 27' 2 cos 36°

tan 13° 23'

5. Find the angle in the following to the nearest minute:

arcsin .7771 arctan .1075

arccos .9130 arccot 1.286

IV. 1. State which of the following are exact and which are approximate numbers:

6 goldfish in a bowl

12 eggs in a box

114 lbs. (Susan's weight)

2 quarts of orange juice

2. How many significant digits are there in each of the following:

250,000 miles

208 centimeters

.025

3. Which measurement is more precise, 72.5 ft. or 73 ft.?

Which measurement is more accurate, 251 miles or 251.5 miles?

4. Add: 72.827 and 1.74.

Multiply: 7.826 x 2.59.

POST TEST

V. 1. Use scientific notation to write:

.0008 meters

1,230,000 miles

2. Express as a rational number without using exponents.

6.42×10^{6}

4.1×10^{-5}

3. Estimate to two significant digits:

$$\frac{(2.08)\ (12.77)\ (121.06)}{21.68}$$

4. - 5. Solve the following and state the laws of exponents used:

$8^4 \cdot 8^5$

$\frac{4^7}{4^3}$

$(6^2)^3$

$\sqrt[3]{2^6}$

6. Use a table of logarithms to find the log .06523

log 1273.5

7. Use logarithms to find:

127.8 x 8976

402.7 ÷ 1.732

$\sqrt{3.14159}$

$(682)^4$

POST TEST

$$\sqrt[3]{7.342}$$

$$\sqrt{\frac{271 \times 432 \times 27}{279}}$$

VI. 1. Solve:

Given a = 44.6 Find A, B, and c.

b = 34.1

Given a = 11.5 Find A, B, and b.

c = 20.4

Given A = 30° 19' Find B, b, and c.

a = 13.5

Given A = 53° 8' Find B, a, and c.

b = 51.5

Given A = 26° 16' Find B, a, and b.

c = 25.4

2. See references, p. 16

VII. 1. See references VII. 1, p. 17

2. (Project done out of classroom)

VIII. To what kinds of angles may trig functions apply?

Is there a value for sin 150° ?

POST TEST ANSWERS

I. 1. a) $x = 10$

b) $x = 5$

c) $x = 10$

d) $x = \frac{1}{33}$

2. Ratio $= \frac{7}{13}$

Ratio $= \frac{9}{5}$

$y = \frac{21}{2}$

II. 1.

$\frac{\sqrt{105}}{50}$ or 10.25

3.27

2. $E_a = 300.7$

$a = 75\sqrt{7}$ or 198.45

3. similar

4. $x = 14$

$y = 10$

5. No, in a right $\triangle$ the other angles are acute.

6. 3600

$\frac{1}{60}$

28° 48' 30"

POST TEST ANSWERS

III. 1. $\sin A = \frac{y}{r}$ $\tan A = \frac{y}{x}$ $\sec A = \frac{r}{x}$

$\cos A = \frac{x}{r}$ $\operatorname{ctn} A = \frac{x}{y}$ $\csc A = \frac{r}{y}$

2. $\sin A = \frac{4}{5} = .8000$

$\cos A = \frac{3}{5} = .6000$

$\tan A = \frac{4}{3} = 1.333$

$\operatorname{ctn} A = .7500$

$\sec A = 1.667$

$\csc A = 1.250$

3. a) $\frac{1}{2}$

b) $\frac{1}{2}$

c) 1

d) $\sqrt{3}$

e) 2

f) $\sqrt{2}$

4. .3467

.3[illegible]

.2379

.1313

1.618

POST TEST ANSWERS

III. 5. 51°

24° 5'

6° 8'

37° 52'

IV. 1. exact

exact

approx.

approx.

2. 2

3

3

3. 72.5

251.5

4. 74.57

20.27

V. 1. 8.0×10^{-4}

1.23×10^{6}

2. 6,420,000

$\frac{41}{100,000}$

3. 140

POST TEST ANSWERS

V. 4. - 5. 8^9 multiplication

4^4 division

6^6 power-power

2^2 M-th root (power-power)

6. $\bar{2}.8144$ or $8.8144 - 10$

3.0050

7. 1.1471×10^6

6.974×10^2

1.7725

2.1635×10^{11}

1.94363×10^{0}

1.0644×10^2

VI. 1. A = 52° 36' B = 36° 52'

B = 37° 24' a = 68.6495

c = 56.1514 c = 85.8505

A = 34° 19' B = 63° 44'

B = 55° 41' a = 11.24204

b = 16.85 b = 22.77618

B = 59° 41'

b = 23.085

c = 26.7435

POST TEST ANSWERS

VII

VIII. acute or obtuse

yes, $\frac{1}{2}$

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